Space Technology Research Grants

Cavity Enhanced Thomson Scattering Diagnostic for Electron Measurements in Weakly Ionized Discharges

Completed Technology Project (2014 - 2018)

Project Introduction

The research plan for the present NSTRF proposal focuses on a new laser diagnostic for measurement of electrons (density and temperature) in electric propulsion (EP) devices. Electron measurements are critical, but conventional probe based measurements are challenging. The proposed method is based on a new version of laser Thomson scattering (LTS) that relies upon a high-power beam, generated in an optical build-up cavity, to increase the scattered photon counts and signal levels. The new approach is enabled by recent technological advances (narrow linewidth fiber lasers, commercial laser locking hardware, and dielectric super mirrors) that will allow a beam power as high as ~10-100 kW, which are several orders of magnitude greater than what is typically used. In this way, the detection limit will be lowered to ~10^10 cm^-3, which will open the door for measurements of electric propulsion devices, such as Hall thrusters (which cannot be readily measured with existing LTS systems). The technique will have high spatial and temporal resolution such that dynamic processes, such as the 'breathing mode', can be studied. Hall thrusters have been acknowledged by NASA in the In-Space Propulsion Systems Roadmap section 2.2.1.2.2 (Hall thrusters) as a technology that will directly support current and future NASA mission goals. Development of physics based models and a more fundamental understanding of the plasma dynamics inside the channel and exhaust plume of the thruster are required for progression of the technology. The proposed research project directly supports this development by presenting a new non-intrusive highly sensitive diagnostic technique. As part of the fellowship, the technology will be transferred to a NASA research facility and will represent a significant upgrade to current probe based diagnostic techniques. Additionally, development of this technique will be of benefit to the plasma research community, as it will also allow measurements in other weakly ionized plasmas (e.g. processing plasmas).

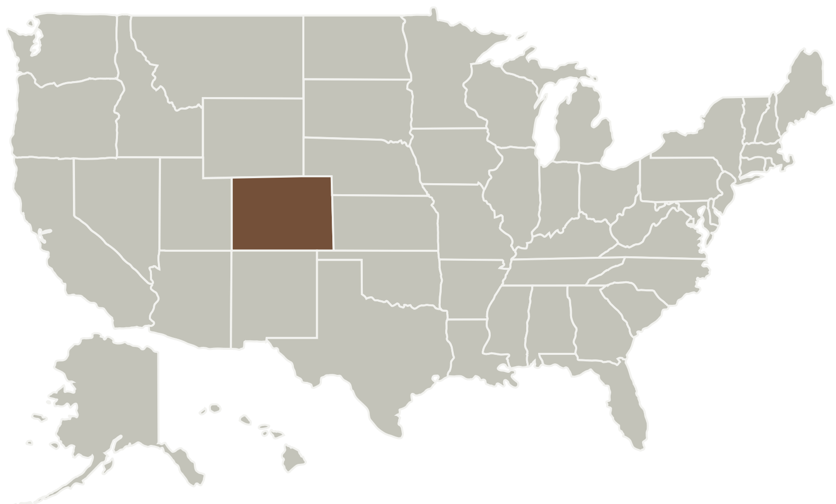
Anticipated Benefits

The proposed research project directly supports this development by presenting a new non-intrusive highly sensitive diagnostic technique. The technology will be transferred to a NASA research facility and will represent a significant upgrade to current probe based diagnostic techniques. Additionally, development of this technique will be of benefit to the plasma research community, as it will also allow measurements in other weakly ionized plasmas (e.g. processing plasmas).

Cavity Enhanced Thomson Scattering Diagnostic for Electron Measurements in Weakly Ionized Discharges

Table of Contents

Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
Colorado State University-Fort Collins	Lead Organization	Academia	Fort Collins, Colorado

Primary U.S. Work Locations
Colorado

Project Website:

https://www.nasa.gov/directorates/spacetech/home/index.html

Organizational Responsibility

Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

Lead Organization:

Colorado State University-Fort Collins

Responsible Program:

Space Technology Research Grants

Project Management

Program Director:

Claudia M Meyer

Program Manager:

Hung D Nguyen

Principal Investigator:

Azer Yalin

Co-Investigator:

Adam Friss

Technology Maturity (TRL)

Start: **2**
Current: **2**
Estimated End: **3**

1 2 3 4 5 6 7 8 9

Applied Research | Development | Demo & Test

Technology Areas

Primary:

- TX01 Propulsion Systems
  └ TX01.2 Electric Space Propulsion
    └ TX01.2.2 Electrostatic

Target Destinations

Foundational Knowledge, Earth